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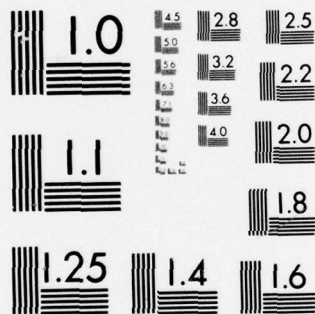
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AN EVALUATION OF NAVY UNRESTRICTED LINE OFFICER
ACCESSION PROGRAMS

Samuel D. Kleinman

CNA — Professional Paper No. 178

April 1977

Presented at the NATO Manpower Planning and
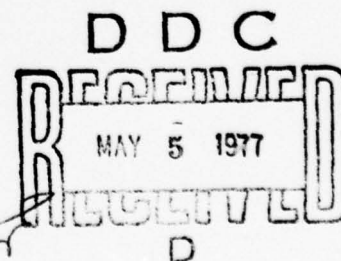Organization Design Conference held in Stresa,
Italy in June 1977.

The ideas expressed in this paper are those of the
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AN EVALUATION OF NAVY UNRESTRICTED LINE OFFICER ACCESSION PROGRAMS

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ABSTRACT

The Navy currently acquires unrestricted line officers through
nine sources that differ widely in their costs and returns. In
this paper, we construct a steady state linear programming model
that solves for the optimal number of accessions from each source.
Costs are minimized subject to the constraint that, for each Navy
occupation, the required number of officers at each rank is met.
The inputs to the model include the present value of costs, the
initial distribution of officers across occupations, retention,
and promotion success. The study finds that some of the expensive
precommissioning programs enter the optimal solution.

INTRODUCTION

The Navy has a number of alternative ways to secure such unrestricted
line officers. These programs range in cost from the apparently
expensive Naval Academy to the apparently inexpensive post-college
programs, such as Officer Candidate School. The benefit to the
Navy also varies with the program. Two of the most easily measured
returns from officer accession training are the retention and pro-
motion success of the commissionees. If the expensive precommis-
sioning programs also produce the greatest returns, it may be in
the best interest of the Navy to maintain these programs. That is,
the apparently expensive programs may be the most cost-effective
in producing middle and upper grade officers.

Officers in the unrestricted line are qualified to command at sea.
Currently, 60% of Naval officers are in this community.

- 1 -

In this paper, we evaluate nine Navy accession programs. These programs, listed in table 1, produce virtually all of the unrestricted line (URL) officers. We examine the ability of these programs to meet the rank requirements of the Navy in six URL designations (occupations). Using a steady state linear programming model, we minimize the life-cycle cost of producing and maintaining officers subject to the constraint that these requirements are met.

TABLE 1

PROGRAMS EVALUATED

Naval Academy (USNA)
Naval Reserve Officer Training Corps, Scholarship (NROTC(S))
Naval Reserve Officer Training Corps, College (NROTC(C))
Reserve Officer Candidate Program (ROC)
Officer Candidate School (OCS)
Aviation Officer Candidate Program (AOC)
Naval Flight Officer Candidate Program (NFOC)
Naval Enlisted Scientific Education Program (NESEP)
Aviation Reserve Officer Candidate Program (AVROC)

This study is an analysis of male officer accessions. Until recently, female officers have been commissioned only by OCS and, in the unrestricted line, they have been confined to a non-warfare designation. Although the number of female URL officers is being increased, women will remain only 5 percent of the community.

The paper proceeds as follows. We first present a short description of previous cost-effectiveness studies of officer accession programs. Next, we develop the model for our analysis and discuss the data. The preliminary findings follow. We have purposely omitted a conclusion and recommendation section, preferring to wait until the final results are firmly established.

PREVIOUS STUDIES

Previous comparisons of the cost-effectiveness of the accession programs are based on precommissioning costs and retention. For example, Hartle (reference 1, p. 113) attempts to estimate the cost per 100 officers reaching the 10 year point for three programs. His estimates are:

USNA	$8,883,000
NROTC(S)	2,930,000
NESEP	4,219,000

His procedure, however, is in error. Accepting his school attrition rates, precommissioning costs, and continuation rates, the figures should be

USNA	$13,407,000
NROTC(S)	9,444,000
NESEP	4,612,000

Hartle appears to believe that to have 100 officers at 10 years of service, when only 46 percent of those starting survive, 154 must be commissioned. In fact, 217 (100/.46) must be commissioned. Hartle also fails to include the cost of attrition at school when calculating the cost of those commissioned but failing to survive to 10 years of service.

Reference 2 reports a similar cost analysis of the above three programs plus OCS. The retention figure in this calculation is the percent reaching two years beyond the minimum service requirement. The precommissioning costs per officer reaching this point are

USNA	$128,910
NROTC(S)	72,318
NESEP	48,339
OCS	114,156

Like the corrected Hartle figures, USNA appears to be the least cost-effective and NESEP the most cost-effective.

Both approaches ignore the post-commissioning costs. Since NESEP officers cost more than other officers for a given rank and year of commissioned service, the two earlier studies overestimate the attractiveness of this program. They also ignore retention beyond 10 years of service and promotion beyond Lieutenant.[1] In this study, we correct for these omissions.

MODEL

Training is an investment in people that is expected to yield future benefits. The idea of investment in human capital is well established in the economics literature (see, for example, references 3 and 4). The costs and benefits over the entire life of the capital should be considered in weighing the merits of alternative training programs. With regard to the officer accession programs, the Navy seeks to minimize the cost of training and maintaining its

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[1] All officers failing promotion to Lieutenant are required to leave. These force-outs are therefore captured in the retention statistics used in the two cited studies.

officers, subject to the constraint of meeting a specified rank pyramid. That is, the cost of a commissioning program should be evaluated relative to the extent that it produces a sufficient number of career officers capable of being promoted to the senior ranks. This approach is similar to the life-cycle costing of hardware. Procurement costs plus operating costs for alternative systems must be compared for a given level of readiness.

The total cost of accessing one cohort of officers can be written compactly as:

$$\sum_{i=1}^{m} a_i X_i \qquad (1)$$

where X_i is the number of accessions from source i, a_i is the expected cost of accessing an individual from the <u>ith</u> commissioning program, and there are m commissioning programs.

The costs that differ by source are precommissioning training costs, base pay, severance pay and the retirement annuity. By source, the expected value of each expenditure is estimated. Next, the expenditures are discounted back (forward) to the date of commissioning. Thus,

$$a_i = \sum_{k=-t_i}^{-1} \frac{T_{ik}}{(1+r)^k} + \sum_{k=0}^{N-1} \frac{C_{ik}}{(1+r)^k} + \sum_{k=0}^{\pi_i-3} \frac{S_{ik}}{(1+r)^k} + \sum_{k=\pi_i}^{V-1} \frac{R_{ik}}{(1+r)^k} \qquad (2)$$

where

t_i is the length of training for source i

T_{ik} is the training cost in year k for source i,

C_{ik} is the expected compensation cost in year k for officers from source i,

S_{ik} is the expected severance pay awarded in year k to officers from source i,

R_{ik} is the expected retirement cost in year k for officers from source i,

r is the discount rate,

N is the longest tenure an officer can have in the Navy,

V is the life expectency from the date of commissioning,

and π_i is the earliest year in which an officer from source i can retire.

For most officers, π_i is 20 years. Since enlisted service is credited toward retirement, officers with enlisted backgrounds are eligible for retirement with less than 20 commissioned years. Also, the Navy does not sever officers who are less than two years from retirement, $\pi_i - 3$ is thus the upper limit on severance pay.

Since the costs are expended over a period of t_i+V years, the costs should be discounted. We argue, in reference 5, that the policy of "growing your own" force necessitates the use of a discount rate. This policy links periods, requiring an opportunity cost of foregone investments. What discount rate to use is a more difficult issue. Reference 6 suggests the use of a 10 percent rate of return. This rate is authorized for evaluating government projects and is specifically required for DOD real property investments (see references 7 and 8). We, therefore, chose to use this rate in our analysis. For comparison, we also report results with undiscounted costs.

T_{ik} has a probability of 1 for an officer being commissioned. However, the probability that an entrant to a program will graduate and be commissioned is less than 1, and this is incorporated into the training cost. Staff and student pay and scholarships, where awarded, are the major costs of the training programs.

Each C_{ik} is computed as follows:

$$C_{ik} = \sum_{j=1}^{n} P_{ijk}C_{ijk}$$

where

P_{ijk} is the probability that an officer commissioned from source i will be in the Navy at year k and be at rank j

C_{ijk} is the compensation for an officer commissioned from source i and of rank j in year k.

Compensation includes base pay, additional pay in certain occupations, allowances, and in-kind benefits. In this analysis, we only calculate base pay, for it is the only cost that differs by source for a given rank and year of commissioned service.

The expected severance pay in year-of-service k for officers commissioned from source i is

$$S_{ik} = \sum_{j=2}^{n} P_{ij*k} S_{ijk}$$

where

$j*$ = j-1 and

S_{ijk} is the severance pay for an officer commissioned through source i and _failing_ to be promoted to rank j in year k.

Most of the S_{ijk} are equal to zero. But, for those failing promotion to O-2 (Lieutenant Junior Grade) through O-4 (Lieutenant Commander) twice, S_{ijk} will have a positive value.

Finally, the retirement pay is

$$R_{ik} = \sum_{\tau=\pi_i}^{k} \sum_{j=1}^{n} A_{ij\tau} R_{ijk\tau}$$

where

$A_{ij\tau}$ is the probability an individual from source i of rank j will retire in year τ, and

$R_{ijk\tau}$ is the retirement cost in year k of an individual from source i and of rank j who retired in year τ.

Equation (1) is minimized subject to the constraint that, for each designation, the specified number of officers at each rank is met. That is,

$$\sum_{k=0}^{N-1} \sum_{i=1}^{m} P_{ijkp} X_i \geq \bar{X}_{jp} \qquad \text{for } j=1,\ldots,n \qquad (3)$$
$$p=1,\ldots,r$$

where P_{ijkp} is the probability that an accession from source i will be in the Navy in year k, of rank j, and in designation p, and $\bar{X}_{jp}$ is the number of officers the Navy specifies for rank j and designation p. We assume here that requirements are stationary across years. Although they are adjusted, a glance at the Navy's projected requirements show only minor changes over a five year period.

There is also an upper constraint on the officer pyramid. Title 10 of the U.S. Code sets limits on the number of Lieutenant Commanders, Commanders, Captains, and Rear Admirals. The constraint is a function of the size of the officer corps. To the extent that the Navy falls short of the permitted number at a given rank, it can

increase the number serving in a lower rank. Letting the sub-
script j signify rank O-j, we have the following

$$\sum_{j=\ell}^{7} \sum_{k=0}^{N-1} \sum_{i=1}^{n} P_{ijk} X_i \leq \sum_{j=\ell}^{7} \overline{X}^*_j \quad \text{for } \ell=4,5,6,7$$

where $\overline{X}^*_j$ is the Title 10 constraint on the $j\underline{th}$ rank. To complete
the model, there is a non-negativity constraint on the X_i's.

Summarizing, and for the moment excluding the Title 10 con-
straint, the problem is to minimize equation (1) subject to con-
straint (3). Minimizing

$$L = \sum_i a_i X_i + \sum_p \sum_j \lambda_{jp} (\overline{X}_{jp} - \sum_k \sum_i P_{ijkp} X_i)$$

with respect to X_i and λ_{jp}, we find that the necessary conditions
for an interior minimum, when all the constraints are binding, is

$$\frac{a_i}{a_{i'}} = \frac{\sum_p \sum_j \lambda_{jp} \sum_k P_{ijkp}}{\sum_p \sum_j \lambda_{jp} \sum_k P_{i'jkp}} \qquad \begin{array}{l} i, i' = 1,\ldots,m \\ i \neq i' \end{array}$$

$$\overline{X}_{jp} - \sum_k \sum_i P_{ijkp} X_i = 0 \qquad \begin{array}{l} j = 1,\ldots,n \\ p = 1,\ldots,r \end{array}$$

Embedded in the a_i is the present value of the training cost.
Analyzing training costs alone is only justified if (1) all post-
commissioning costs are independent of source and (2) retention rates,
promotion rates, and the distribution of officers across designations
is independent of source.

DATA

To make the model operational, six types of data are required:
the source-designation distribution, retention rates, promotion rates,
precommissioning costs, postcommissioning costs, and requirements.
Where our estimates differ from those supplied by the Navy, we use
both sets in our analysis.

Source-Designation Distribution

The distribution of officers by designation was based on the
distribution of those commissioned in FY 1973 and FY 1974 (see re-
ference 9 for the procedure). Because of a recent redesignation
of most officers in the nonwarfare designation and movement be-
tween designations in the first year, we had to follow officers for
a year or two to establish where they finally resided. Since the
distributions estimated are for one or two years after entry, we
cannot use them to meet Ensign rank requirements within designations.
We therefore eliminated the Ensign rank constraint.

Retention

Within each designation, we estimated the probability that
an officer from a given source will survive to each year of service.
The survival rates are based on actual retention from 30 June 1972
through 30 June 1975. Since some programs did not exist 25 years
ago, we had to choose similar programs from which to compute their
survival rates. For most programs, the rates drop sharply up to
the 6th year of service. This reflects the end of the minimum service
requirement. After the sixth year, the drop in survival rates con-
tinues but at a slower pace. At about the 11th year of service, the
survival rates flatten out. At the 20th year of service the rates
again decline, when officers become eligible for the retirement
annuity and Lieutenant Commanders are forced to leave.

For officers commissioned from the program that is exclusively
for enlisted personnel, NESEP, retention is very high out to the 9th
year of service. After this point, there is a major loss of personnel.
Clearly, crediting enlisted time toward retirement induces most of
these officers to acquire 20 years of total service and less than
20 years of commissioned service.

Promotion

We assume that all officers are promoted to Lieutenant Junior
Grade. For promotion from Lieutenant to Captain, promotion rates are
estimated separately for early, on time, and late selection by re-
gression analysis. The data is from FY 1973 through FY 1976 and
grouped by source and designation. Three functional forms were
compared in their ability to predict promotion. The standard logistic
model was found to perform best.[1] The regression equation estimated
is

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[1]The criteria were minimizing $\sum_j N_j(\hat{Q}_j-Q_j)^2$ and $\sum_j |N_j(\hat{Q}_j-Q_j)|$. The
result of the tests and all the regression results are reported in
reference 10.

$$\log \frac{Q}{1-Q} = \beta_0 + \sum_i \beta_i Z_i + \varepsilon$$

where Q is the probability of promotion of those eligible. The observations are weighted by the square root of $EQ(1-Q)$, where E is the eligible population in each cell. The Z_i's are dummy variables for each source and designation. It was assumed that there are no interaction effects.

Precommissioning Costs

We use two sets of precommissioning costs. The first set was supplied by the Navy. These costs are undiscounted and not corrected for inflation. We next recomputed all costs, adjusting for inflation and discounting. Even before the adjustments, our costs were not exactly equal to the Navy's. For example, the Navy's NESEP costs include the tuition of some students. Since tuition will no longer be paid by the Navy, we omitted this cost. Also the aviation commissioning programs (AOC, NFOC, and AVROC) appear to include high overhead costs for the maintenance of expensive equipment. Since these costs are not related to the initial training, our recalculated costs were far lower. All costs are in FY 1976 dollars.

Postcommissioning Costs

We include in these costs base, severance, and retirement pays. All three differ according to years of service credited prior to commissioning. NESEP officers are credited for their enlisted time, including time in the program, and we assume this credit is for seven years. AVROC and ROC officers are credited for their school time while in the program, and this credit is assumed equal to two years.

At commissioning, the value of the retirement is

$$R = \frac{BP \times .025 \times Yr}{r(1+r)^a} \left(1+r - \frac{1}{(1+r)^{L-a-1}}\right)$$

where

    BP   is base pay in the final year,

    Yr   is years of service credited for retirement,

    L   is the expected lifetime, and it is assumed that an individual dies at the end of L-1, and

      a   is the age at retirement, where it is assumed that the individual retires at the beginning of the year.

When $r = 0$, the equation becomes

$$R = BP \times .025 \times Yr \times (L-a-1)$$

In our computations, we assume that the annuity is paid in the middle of the year. Thus, instead of t, we use $t+.5$.

Life expectancy is based on 1973 data for white males (see reference 11). For each five year interval from ages 35 to 60, the midpoint was used to predict the expected remaining life. The estimated simple regression was

$$ERL = 48.7809 - .009002A^2$$

where ERL is the expected remaining life and A is age. We assume all NESEP officers are 39 years old after 20 years of service and all other officers are 42.

Requirements

The official Navy requirements are reported in the Officer Requirements Plan (ORP). We used the FY 1977 requirements published in the 1 June 1976 report (reference 12). There are requirements for five warfare areas by rank: surface, submarine, special, pilot, and officer flight crew. There is also a requirement for the aviation community, which includes the latter two warfare areas plus a small nonflying designation. There is a cumulative requirement for all warfare areas and a requirement for the entire unrestricted line. Since almost all men will be designated to a warfare area in the future, we exclude the cumulative warfare area requirement in the analysis. In the results reported here, the unrestricted line requirements are reduced by the female officers in the community.

As discussed above, Ensign requirements are excluded. In the exploratory stage of the analysis, we found that Lieutenant Junior Grade requirements were large, necessitating a large number of accessions to meet them. These requirements were established when the promotion point to this rank was 18 months after commissioning. When promotions were delayed to two years, the requirements were not readjusted, resulting in unrealistic demands. Since officers now hold the two junior ranks for two years each, we used the average of the requirements as the new Lieutenant Junior Grade requirements.

We also relaxed the constraints that a fixed number of officers at each rank is required. We merged adjacent rank requirements.

It was assumed here, for example, that a Commander billet could be filled by a Lieutenant Commander without loss of effectiveness.

FINDINGS

In this section, we highlight some of the preliminary findings. Although we believe life-cycle costs should be minimized in the objective function, we offer alternative criteria for comparison. Title 10 constraints have not, as yet, been included in the model. All computer runs were performed on the Center for Naval Analyses' CDC 3800. The linear programming code, known as LPREVISE, is documented in reference 13.

In table 2, we report the accession programs in the optimal solutions when minimizing accessions and the number of URL officers in the Navy. The Naval Academy, whose graduates serve the longest, and NFOC always enter. The presence of NFOC reflects, to some degree, the limit at the Academy on the number of midshipmen that can enter the Naval Flight Officers designation. Merging adjacent rank requirements does not alter the findings. Also, although minimizing accessions results in fewer accessions, it results in a far larger officer corps.

TABLE 2

SOURCES IN THE OPTIMAL SOLUTION WHEN MINIMIZING ACCESSIONS AND THE NUMBER IN SERVICE[a]

	Minimize accessions		Minimize number in service	
	Unmerged	Merged	Unmerged	Merged
USNA	X	X	X	X
NROTC(S)			X	X
NROTC(C)				
ROC				
OCS				
AOC				
NFOC	X	X	X	X
NESEP			X	X
AVROC			X	X
Accessions	3,933	3,933	4,305	4,230
No. in service	54,657	54,657	39,442	38,605

[a]An X in a cell signifies that the source is in the optimal solution.

We next considered the accession mix when minimizing pre-
commissioning costs. These results are displayed in table 3. To
no one's surprise, three of the cheapest accession programs
entered as the most desirable sources. Since there is no attempt
to minimize the number in service or the cost associated with them,
a large number of officers are accessed and maintained in service
in this solution. Neither using the OPRA precommission cost esti-
mates, using a discount rate, nor merging adjacent rank require-
ments alters the basic findings.[1] Since OCS, AOC, and NFOC are the
only one year programs, discounting has the effect of raising the
relative costs of programs that were not already in the optimal
solution.

TABLE 3

SOURCES IN THE OPTIMAL SOLUTION WHEN
MINIMIZING PRECOMMISSIONING COSTS[a]

| | Navy estimates | | OPRA estimates | | | |
| | | | R=0.0 | | R=0.1 | |
	Unmerged	Merged	Unmerged	Merged	Unmerged	Merged
USNA						
NROTC(S)						
NROTC(C)						
ROC						
OCS	X	X	X	X	X	X
AOC	X	X	X	X	X	X
NFOC	X	X	X	X	X	X
NESEP	X					
AVROC						
Accessions	9,727	9,645	11,207	9,645	11,207	9,645
No. in service	64,344	62,045	71,521	62,045	71,521	62,045

[a]An X in a cell signifies that the source is in the optimal
solution.

[1]The acronym OPRA is for the Officer Procurement, Retention, and
Achievement Study. The research reported here is part of this
larger study, and we have maintained the acronym throughout this
section to refer to the use of our estiamtes of precommissioning
costs.

Finally, we minimize the life-cycle cost of the accessions. As reported above, base, severance, and retirement pays differ by program. Minimizing these expenditures, along with the precommissioning costs, produces the results in table 4. These are the results we are most interested in, for they include all the costs. Since undiscounted results were almost identical to those discounted, they have been omitted from the table. The three programs with the most costly precommissioning training - USNA, NROTC(S), and NESEP - are in the optimal solution. This is partly explained by the high retention of their graduates. The results do not differ appreciably when we reestimate precommissioning costs or merge adjacent rank requirements.

TABLE 4

SOURCES IN THE OPTIMAL SOLUTION WHEN
MINIMIZING PRECOMMISSIONING COSTS, BASE PAY,
SEVERANCE PAY, AND RETIREMENT[a]
R=0.1

	Navy estimates		OPRA estimates		OPRA estimates: NROTC(S) constrained	
	Unmerged	Merged	Unmerged	Merged	Unmerged	Merged
USNA	X	X	X	X	X	X
NROTC(S)	X	X	X	X	X	X
NROTC(C)						
ROC						
OCS		X	X	X	X	X
AOC	X	X	X	X	X	X
NFOC	X	X	X	X	X	X
NESEP	X	X	X	X	X	X
AVROC						
Accessions	4,374	4,560	4,650	4,560	4,986	4,950
No. in service	39,541	39,198	40,422	39,198	42,161	41,599

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[a]An X in a cell signifies that the source is in the optimal solution.

Of those sources in the optimal solution, only NROTC(S) is sufficiently above its previous accession levels to warrant concern. We therefore imposed a secondary constraint on this source of 2,000. This is approximately 60 percent above its highest post-Korean War level. The solution does not change appreciably. No new sources enter. All the other sources expand, with NFOC having the greatest expansion.

Some summary statistics of the solutions minimizing discounted life-cycle costs are reported in table 5. The percent that are at the rank Lieutenant Commander or above gives the percent of the officer corps in the middle and higher ranks. Currently, 36 percent of the URL community are in the middle and higher grades. The Navy is also concerned with maintaining a mix of Regular and Reserve officers. Regular officers enter through only three programs – USNA, NROTC(S), and NESEP. In the past three years, 51 percent of the accessions have been Regular officers. This percent is only approached when we constrain NROTC(S). Although these costs are for solutions minimizing discounted costs, the costs reported are undiscounted. The precommissioning costs are the OPRA estimates. In all, over $1 billion is spent on a cohort in precommissioning training, base, severance, and retirement pays.

TABLE 5

SUMMARY STATISTICS OF OPTIMAL SOLUTIONS
WHEN MINIMIZING OPRA PRECOMMISSIONING COSTS, BASE,
SEVERANCE, AND RETIREMENT PAYS
R=0.1

| | NROTC unconstrained | | NROTC constrained | |
	Unmerged	Merged	Unmerged	Merged
Percent LCDR and above	37%	37%	36%	36%
Percent Regular	68%	73%	55%	55%
Precommissioning costs ($M)	137.5	131.8	127.1	123.5
Base & severance pays ($M)	616.6	595.9	642.6	634.0
Retirement pay ($M)	389.4	374.1	404.0	396.9
Total expenditures ($M)	1,143.5	1,101.8	1,173.7	1,154.4

The findings reported here are preliminary. Based on the final results, recommendations will be made to the Navy. We believe the Navy will seriously consider our proposals, since this has been the most rigorous attempt to evaluate their officer accession programs. Also, we have shown that the apparently expensive programs can be justified by cost-benefit analyses. This has been averred by the Navy without the type of analytical support supplied here.

REFERENCES

1. Hartle, Christopher Maurice, "A Comparative Study of the Professional Performance of Selected Naval Enlisted Scientific Educational Program (NESEP) Officers, Naval Reserve Officer Training Corps (NROTC) Officers, and United States Naval Academy (USNA) Officers for the Period 1962-1972 as Related to Their Educational Programs," unpublished doctoral dissertation, Miami University, Oxford, Ohio, 1973.

2. "Cost vs. Retention - Officer Accession Programs," Chief of Naval Education and Training, N-62, 1 Aug 1975.

3. Becker, G., "Investment in Human Capital, A Theoretical Analysis," Journal of Political Economy, Oct 1962, pp. 9-49.

4. Oi, Walter, "Labor as a Quasi-Fixed Factor," Journal of Political Economy, Dec 1962, pp. 538-55.

5. Center for Naval Analyses, Memorandum (CNA)1646-75.10, "Discounting in a Steady-State Navy Manpower Model," by Samuel Kleinman, 22 Dec 1975.

6. Stockfisch, J.A., "Measuring the Opportunity Cost of Government Investments," Research Paper P-490, Institute for Defense Analysis, Arlington, Va., 1969.

7. Office of Management and Budget, Circular No. A-94, revised, "Discount Rates to be Used in Evaluating Time-Distributed Costs and Benefits," 27 Mar 1972.

8. DOD Instruction 7041.3, "Economic Analysis and Program Evaluation for Resource Management," 18 Oct 1972.

9. Center for Naval Analyses, Memorandum (CNA)76-1660.10, "Distribution of Officers by Source Across Designations," by Karen W. Goudreau, 24 Nov 1976.

10. Center for Naval Analyses, Memorandum (CNA)76-0729, "Promotion Rates of Unrestricted Line Officers by Source and Designation," by Samuel Kleinman, 12 May 1976.

11. The 1975 World Almanac, table "Average Future Lifetime in United States," Newspaper Enterprise Association, Inc., New York, 1974, p. 955.

12. Chief of Naval Operations, "Officer Requirements Plan, Fiscal Years 1976-1980," Unclassified, 11 Jun 1976.

13. Mylander, W. Charles, "Users Manual for the Linear-Programming System LPREVISE," U.S. Naval Academy, Jun 1975.

CNA Professional Papers — 1973 to Present *

PP 103
Friedheim, Robert L., "Political Aspects of Ocean Ecology" 48 pp., Feb 1973, published in Who Protects the Oceans, John Lawrence Hargrove (ed.) (St. Paul: West Publ'g. Co., 1974), published by the American Society of International Law) AD 757 936

PP 104
Schick, Jack M., "A Review of James Cable, Gunboat Diplomacy Political Applications of Limited Naval Forces," 5 pp., Feb 1973, (Reviewed in the American Political Science Review, Vol. LXVI, Dec 1972)

PP 105
Corn, Robert J. and Phillips, Gary R., "On Optimal Correction of Gunfire Errors," 22 pp., Mar 1973, AD 761 674

PP 106
Stoloff, Peter H., "User's Guide for Generalized Factor Analysis Program (FACTAN)," 35 pp., Feb 1973, (Includes an addendum published Aug 1974) AD 758 824

PP 107
Stoloff, Peter H., "Relating Factor Analytically Derived Measures to Exogenous Variables," 17 pp., Mar 1973, AD 758 820

PP 108
McConnell, James M. and Kelly, Anne M., "Superpower Naval Diplomacy in the Indo-Pakistani Crisis," 14 pp., 5 Feb 1973, (Published, with revisions, in Survival, Nov/Dec 1973) AD 761 675

PP 109
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Augusta, Joseph, "A Critique of Cost Analysis," 9 pp., Jul 1973, AD 766 376

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*University of Florida.
**Research supported in part under Office of Naval Research Contract N00014-68-0273-0017

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Barfoot, C. Bernard, "Markov Duels," 18 pp., Apr 1973, (Reprinted from Operations Research, Vol. 22, No. 2, Mar-Apr 1974)

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*Economics, North Carolina State University.

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Friedheim, Robert L. and Jehn, Mary E., "Anticipating Soviet Behavior at the Third U.N. Law of the Sea Conference: USSR Positions and Dilemmas," 37 pp., 10 Apr 1974, (Published in Soviet Naval Policy, ed. Michael MccGwire; New York: Praeger) AD 783 701

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PP 126 – Classified.

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*Mathematica, Inc.

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Mizrahi, Maurice M., "Generalized Hermite Polynomials,"* 5 pp., Feb 1976 (Reprinted from the Journal of Computational and Applied Mathematics, Vol. 1, No. 4 (1975), 273-277).
*Research supported by the National Science Foundation

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*Research supported by the National Science Foundation

PP 153
Mizrahi, Maurice M., "WKB Expansions by Path Integrals, With Applications to the Anharmonic Oscillator,"* 137 pp., May 1976 (Submitted for publication in Annals of Physics). AD A025 440
*Research supported by the National Science Foundation

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Mizrahi, Maurice M., "On the Semi-Classical Expansion in Quantum Mechanics for Arbitrary Hamiltonians," 19 pp., May 1976 (To appear in the Journal of Mathematical Physics) AD A025 441

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